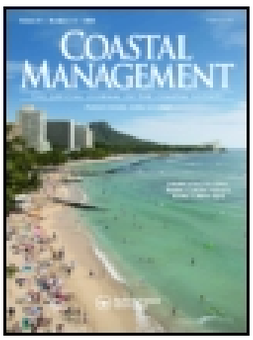

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The Impact of Access Restrictions on Fishery Income Diversification of US West Coast Fishermen

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ABSTRACT

Access to most fisheries on the US West Coast was essentially open prior to the mid-1970s when state licenses were first limited for salmon fisheries. Subsequently, licenses to most fisheries on the West Coast have been limited, and the numbers of licenses in many fisheries have been reduced with buy-back programs. More recently, catch share programs, which dedicate exclusive shares of catch to individuals or cooperatives, have been introduced in several sectors of the federally managed Pacific groundfish fishery. As access to fisheries has become more restricted, revenue diversification of West Coast fishing vessels has generally declined. This is a source of concern since diversification has been shown to reduce year-to-year variation in revenue and hence financial risk. However, catch share programs may create more security and stability in vessels' landings, which may offset effects of less diversification. Nevertheless, there may be a tradeoff between the efficiency gains enabled by restricting access and risk-reduction benefits associated with greater diversification.

KEYWORDS

catch shares; cooperatives; diversification; IFQ; limited entry

Introduction

Revenues of fishermen can vary dramatically from year to year due to variability in catches and prices. However, the variability of fishing revenue is, on average, lower for fishing vessels that participate in several different fisheries (Kasperski and Holland 2013). Data on vessels landing fish in US West Coast ports indicate that many, but by no means all, vessels do diversify by participating in more than one fishery. Many vessels also fish in different regions, some moving between the West Coast and Alaska during the year. However, as we show, the average level of diversification of West Coast vessels has generally declined since the early 1990s as access to fisheries has become more restricted.

The ability of US West Coast fishermen to diversify revenues by moving into and between fisheries was largely unrestricted until the mid-1970s. With a few exceptions,

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such as shellfish in subtidal zones in Washington and Abalone in California, most West Coast fisheries were open access. However, in response to growing concerns about overfishing and collapse of fish stocks, fishery management authorities began to limit access to ocean fisheries. Salmon fisheries were some of the first major fisheries to have limited license programs implemented, with license limitations going into effect in Washington in 1974, and in Oregon and California in 1979 (Rettig 1984). Initial qualification standards for salmon licenses were very permissive, and the licensed fleets were too large and overcapitalized. The degree of overcapitalization was worsened by a 1974 court decision known as the Boldt decision [United States v. Washington, 384 F. Supp. 312 (W.D. Wash. 1974), aff'd, 520 F.2d 676 (9th Cir. 1975], which allocated 50% of Washington salmon harvest to Native American tribes cutting in half the catch available to the extant commercial fleets. The recognition of a need to reduce capacity led to a series of vessel and license buybacks in salmon fisheries in Oregon and Washington beginning in 1975 and continuing in 1990s (Holland, Gudmundsson, and Gates 1999). Licenses in the Dungeness crab fishery, another state-managed fishery, were limited in 1994 in Washington (WDFW 2008), and in 1995 in California and Oregon. Licenses were limited in the federally managed West Coast groundfish fishery in 1994. In 2003, there was an industry-funded license buyback that removed one-third of active licenses accounting for 40% of the 2002 revenues for that fleet (PFMC and NMFS 2010). While need for these license limitation programs, and the need to further reduce the licensed capacity, was clear in all these cases, these management actions also had the effect of limiting the ability of fishermen to build or maintain diverse fishing portfolios.

License limitation programs alone generally failed to constrain catches to sustainable levels, requiring additional regulations that restricted when and where fishing was allowed or how much could be landed by individual fishermen. These types of regulations led to derby fisheries in the limited entry fixed gear sablefish fishery and the Pacific whiting fishery, and to large area closures and high rates of discards in the limited entry groundfish bottom trawl fishery. To address problems and inefficiencies associated with these management approaches, the Pacific Fishery Management Council (PFMC) introduced "catch shares" programs, which allocated exclusive shares of the total allowable catch (TAC) as individual fishing quotas (IFQs) or as group allocations to harvest cooperatives. The limited entry fixed gear sablefish fishery on the West Coast implemented a tiered license system in 1998, and permit stacking (the ability to stack multiple permits on a single vessel to increase allowable catch) was allowed beginning in 2001. Permit stacking effectively created an IFQ, which ended the derby fishery in 2002 and thereafter. In the limited entry groundfish trawl fishery, an IFQ was implemented beginning in 2011. The IFQ system included the multispecies bottom trawl fishery as well as the shoreside component to the Pacific whiting fishery (i.e., the vessels delivering to shore plants). The catcher-processors in the Pacific whiting fishery had been operating a self-organized cooperative since 1997, but the 2011 management action formalized this and extended cooperative management to the mother ship sector (fleets of catcher vessels that deliver to mobile floating processors). The catcher-processors and vessels delivering to mother ships are collectively referred to as the at-sea whiting fleet.

Catch shares, both for IFQs and cooperatives, have generally been allocated free of charge to existing participants on the basis of recent catch history. However, since

most of the fisheries were overcapitalized prior to implementation of catch shares, there has been some consolidation with some permit owners selling or leasing the catch shares they were allocated and exiting the fishery. While this consolidation can be expected to increase efficiency by lowering fixed costs and removing less efficient vessels, it could also reduce the diversification both for those that exit the catch share fishery and those that remain. The vessels that remain in the catch share fishery may experience a longer fishing season and increased catch from the catch share fishery, but this tends to displace their participation in other fisheries. Decisions to remain in the fishery and become more specialized presumably are driven by expectations of higher profitability. Vessels that exited the catch share fishery may find few opportunities to replace the revenues from the catch share fishery since access to most fisheries is now closed. On the other hand, catch shares provide an opportunity for fishermen to purchase small amounts of quota and enter (or re-enter) the fishery without having to acquire a full limited access license and associated history.

The trends toward restricting access to fisheries, and more recently to an exclusive share of the TAC, raise important questions about whether and how these restrictions have affected the ability of fishermen to diversify their fishing activity. Climate change and ocean acidification are expected to change the distribution and productivity of individual fisheries and may increase volatility in productivity as well (National Research Council 2010). Thus, the importance of diversification as a risk-reduction strategy may increase. In this study, we document trends in average diversification over time for vessels participating in West Coast fisheries and evaluate whether major management actions that limited participation were associated with significant changes in diversification. In particular, we evaluate how diversification changed following implementation of catch share programs. Our analysis confirms a decreasing trend in diversification over the last few decades overall for West Coast fishing vessels. These trends began in the early 1990s coincident with broad implementation of limited access programs. Diversification continued to decline following implementation of catch share programs both for vessels that remained active in the catch share program and those that exited but continued fishing in other fisheries. We do not, however, find an increase in year-to-year variation in revenues following implementation of catch shares.

Methods and data

Following Kasperski and Holland (2013), we measure diversification of West Coast and Alaskan vessels' gross revenues across species groups and regions each year. Although we would ideally like to evaluate diversification of individual fishermen rather than vessels, data limitations require us to use vessels as a proxy for fishermen.[1] Our focus in this paper is primarily on vessels fishing off the West Coast. However, we include Alaskan vessels and fisheries as well because many vessels fish in both regions, and it is essential to consider the entire fishing portfolio of each vessel when evaluating its level of diversification. As a measure of diversification, we utilize the effective Shannon index (ESI) (Jost 2006) defined as[2]:

$$\mathrm{ESI} = \exp\left[-\sum_{i=1}^{S_j}\sum_{j=1}^{4}\left(p_{ij}{}^{*}\ln\ p_{ij}\right)\right] \tag{1}$$

Table 1. Species groups used for diversification indices.

West Coast	Alaska
Pacific whiting	Pacific cod
Dover sole, thornyheads, sablefish	Flatfish
Rockfish and flatfish	Rockfish
Skate, dogfish, sharks	Atka mackerel
Pacific halibut	Pollock
California halibut, croaker	Other groundfish
Pink shrimp	Sablefish
Other prawns and shrimp	Pacific halibut
Crab	Herring
Salmon	Chinook salmon
Tuna	Sockeye salmon
Herring	Coho salmon
Coastal Pelagics	Pink salmon
Echinoderms	Chum salmon
Other shellfish	Other salmon
Squid	Red king crab
Other species	Other king crab
	Opilio crab
	Other snow crab (Bairdi)
	Other crab
	Scallops
	Other shellfish
	Other species

where p_{ij} represents the proportion of a vessel's total gross revenues derived from species group i in region j and S_j is the total number of species groupings in region j. We define p_{ij} to be the percent of a vessel's total annual gross revenue from one of 40 different species groupings in one of four regions—the Bering Sea/Aleutian Islands, Gulf of Alaska, Alaskan in-state waters, and the West Coast (Table 1). Not every species group is caught in each region; therefore, there are a total of 84 region-specific species groupings. The ESI takes a value of 1 when revenues are all from a single species and region. It increases both as revenues are spread across more fisheries and as revenues are spread more evenly across fisheries (Figure 1). When revenues are spread evenly across fisheries, the ESI has an intuitive meaning. It takes a value of 2 if fishery revenues were spread evenly across 2 fisheries, a value of 3 if spread evenly across 3 fisheries, and so on. If the revenue is not evenly distributed across fisheries, the ESI value is lower than the number of fisheries. For example, a 60–30–10 percent split of revenues between three fisheries would yield an ESI of 2.45. A quite uneven spread of revenue across four fisheries (e.g., 75–10–10–5 split) can yield a lower ESI (ESI = 2.28) than an even spread across three fisheries (ESI = 3.00).

We work with a large data set that includes annual landings and revenues between 1981 and 2013 by species, port, and vessel from all commercial fisheries in the US exclusive economic zone (EEZ) off the US West Coast and Alaska. We begin with a pool of 28,151 vessels with average West Coast and Alaska fishing revenues over $5000 (adjusted to 2005 values) and at least 2 years[3] of documented landings. Using the ESI as a metric, we calculate annual diversification scores for all vessels for the years 1981–2013.

We first examine trends in diversification for all vessels fishing off the West Coast and Alaska and then consider a subset of the fleet that includes 2,777 vessels with West Coast revenues greater than $5,000 in 2013. Within this subset, we then examine trends of subgroups of West Coast vessels categorized by which state they primarily land fish on the West

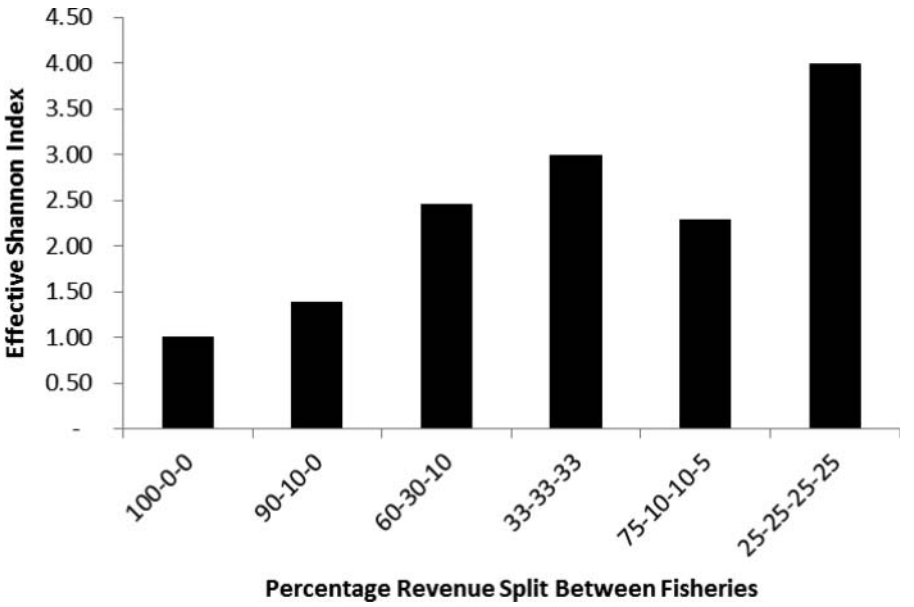

Figure 1. Effective Shannon index values for different distributions of fishery revenue across fishery groupings.

Coast, by revenue and size classes, and by participation in various fisheries that have implemented catch shares. For fleets of vessels that had been participating in fisheries in which catch share programs were introduced, we examine pre- and post-diversification levels for those vessels. We also compare average ESI scores for vessels that remained in the catch share fisheries with those that exited the catch share fishery but continued participating in other fisheries.[4]

Kasperski and Holland (2013) found that diversification was inversely correlated with year-to-year variation in income, and consequently, it might reduce financial risk. However, catch share programs, even if they reduce diversification, may also serve to stabilize vessel-level landings as well as increase revenues for vessels that remain in the fishery (as a result of consolidation and potentially increasing the value of landings). To evaluate this, we calculated the average vessel revenues and the coefficient of variation (CV) of vessels' revenues in the years prior to and following implementation of the four catch share fisheries. In each case, we considered average revenues for balanced panels of vessels that were active both before and after the catch share program was implemented and calculated the average revenue and CV based on an equal number of years before and after catch share implementation (limited to 3 years for all but the fixed gear sablefish for which we calculated average and CV of revenue over 7-year period pre and post).

Results

The average ESI for most vessel groups, although erratic,[5] has generally been decreasing over time, demonstrating that diversification of fishery revenue has been declining on average. The current fleet of vessels fishing the US West Coast and Alaskan fisheries (those that fished

in 2013) was, on average, less diverse than at any point in the past 30 years (the gray line in Figure 2A).There is a great deal of variability in diversification across individual vessels and groups of vessels (Figure 2 and 3). The causes of the decline in diversification are not completely clear and vary by fleet sector. One likely factor that correlates with the observed trend is the successive implementation and tightening of limited access programs and, subsequently, introduction of catch share programs. By the mid-1990s, entry into new fisheries was no longer possible for most vessels since nearly all fisheries had moratoriums on entry, and some were beginning to reduce fleets through vessel buybacks, and later, catch share programs. These programs limit fishermen's ability to move into new fisheries and often push out less active participants from a fishery. This is often necessary to limit catch and improve economic viability of the remaining participants, but it can also result in decreased diversification. Vessels involved in West Coast fisheries since 1981 and still active in 2013 have maintained a higher level of diversification than the overall current fleet, while vessels that entered later tend to be less diversified, possibly due to limited access programs in many fisheries (Figure 2A). Another factor contributing to the decline in diversification may be related to the increasing dominance of the Dungeness crab fishery as a key source of revenues for large numbers of West Coast vessels. Dungeness crab accounted for nearly 40% of West Coast ex-vessel revenues in 2013.

We also look specifically at diversification trends for vessels with at least $5,000 in revenues from landings in WA, OR, or CA in 2013 (Figure 2B–D). Overall, trends for vessels fishing the West Coast are similar to those for the larger fleet of vessels fishing the West Coast and/or Alaska. However, the decline in diversification began earlier for California vessels and, on average, California vessels tend to be less diversified than Oregon or Washington vessels (Figure 2B). The Oregon fleet actually reached a peak average level of diversification in 1997, but average ESI for the Oregon fleet has generally declined since. Up through the early 1990s, the Washington fleet was the most diversified of the three states' fleets, but average ESI for Washington vessels decreased below that of Oregon vessels after 1996.

For smaller West Coast vessels, diversification has declined only slightly since 1981, while, for larger vessels, diversification increased through the early 1990s but mostly declined thereafter (Figure 2C). Smaller vessels ($<=$ 40 feet in length) tend to have lower levels of diversification than larger ones on average. This may be due in part to their lack of mobility and inability to participate in fisheries far from shore. The largest class of vessels (81–135 feet) was the most diversified size class from the 1990s until recently, but average diversification for that class of vessels declined below that of the intermediate size class of vessels (41–80 feet) in 2013.

Vessel length is strongly correlated with average annual revenue, and we see somewhat similar trends and relative differences in diversification when categorizing vessels by average annual revenue (Figure 2D). Vessels with less than $25,000 in average revenues tend to have low diversification levels, and there has not been a distinct trend in their diversification over time. Vessels with average revenue between $25,000 and 100,000 are, on average, more diversified than lower income vessels. Their average diversification levels have been declining since the mid-1980s. Average diversification levels for vessels with average revenue over $100,000 are again higher than lower revenue vessel classes, but diversification peaked later, in 1994, and declined thereafter.

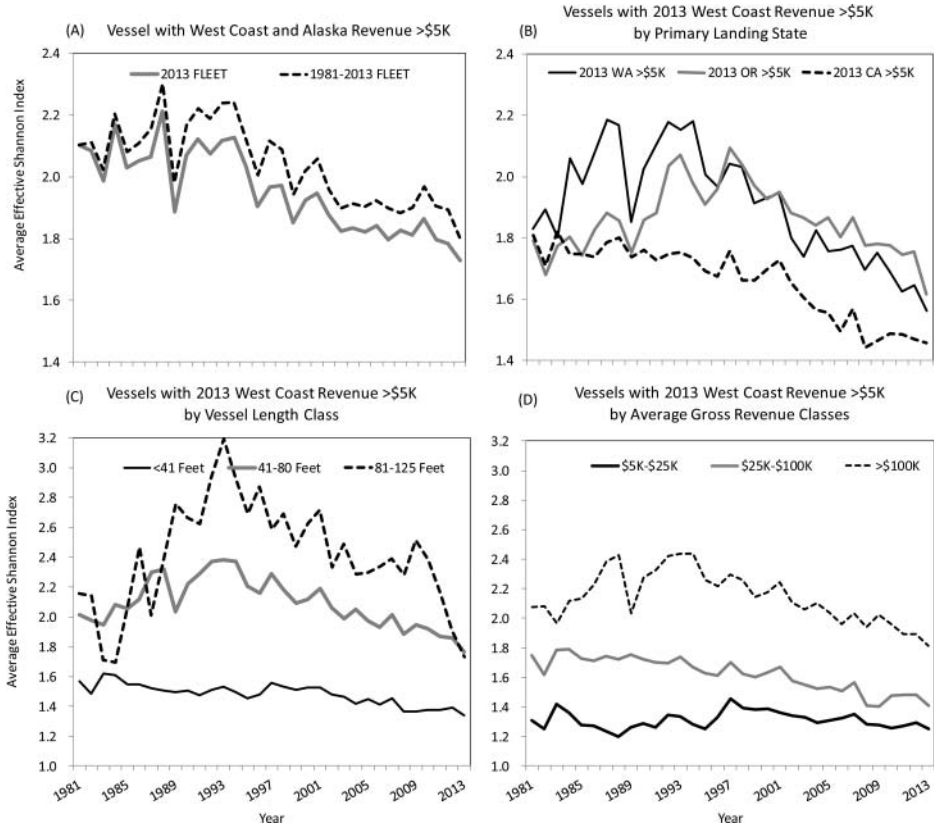

Figure 2. Trends in average diversification measured by the effective Shannon index (A) for US West Coast and Alaska fishing vessels with average revenue over $5,000 and for vessels with 2013 West Coast Revenues over $5,000 by (B) primary West Coast landing state, (C) vessel length classes, and (D) average gross revenues classes.

Impacts of catch shares on diversification of fishery participants

The limited entry fixed gear sablefish fishery was the first West Coast fishery to implement a catch share system; 2002 was the first full year under the permit stacking program. Diversification for vessels that remained in the catch share fishery had increased slightly between 1987 (when separate TACs for fixed gear and trawl fleets were first introduced) and 2002, but there was no clear trend (Figure 3A). After 2002, diversification declined significantly.A two-tailed *t*-test comparing average diversification levels from 1987 to 2001 with those after 2001 indicates a lower average ESI post 2001 at the 0.01 significance level. For the vessels that had been active in the fishery between 1998 and 2001, but did not participate once permit stacking was implemented, average ESI had already been declining since 1998 after the three-tier permit system was implemented (Figure 3A). ESI for this group leveled out after 2001, but at a significantly lower level after 2001 than it had been between 1987 and 2001. Both before and after 2002, average diversification for these vessels was also substantially lower than that for the vessels that remained in the sablefish fishery after 2001.

The groundfish trawl IFQ implemented in 2011 includes both a multispecies bottom trawl fishery and a distinct fishery that targets Pacific whiting with mid-water trawl gear, which we

evaluate separately. Although we can construct our diversification measures for only 3 years post IFQ, we do find that average ESI levels for non-whiting groundfish vessels are significantly lower than in the 2004–2010 period both for vessels that remained in the IFQ fishery and for those that did not participate in the IFQ but remained fishing in other fisheries (Figure 3C). *t*-tests of average ESI for both groups show significantly lower ESI after 2010 at the 0.01 significance level. The decline is particularly large for vessels that did not fish in the IFQ. As with the sablefish fixed gear fleet, the vessels that exited the catch share fishery were less diversified on average than those that remained in the IFQ fishery, both before and after the catch share program was implemented.

The domestic Pacific whiting fishery developed later than the bottom trawl fishery, taking over operations of the foreign and then joint venture fleets. The vessels are larger than most that participate in the bottom trawl fishery, and many participate in the Eastern Bering Sea pollock fishery. Consequently, changes in diversification for this fleet appear to have been driven as much by regulatory changes in the pollock fishery as by implementation of catch shares for Pacific whiting. For the shoreside whiting vessels that ultimately did not participate in the IFQ, average ESI had been rising until 1997 but began to decline leading up to and following the implementation of the American Fisheries Act (AFA), which rationalized the shoreside Eastern Bering Sea pollock fishery in 2000 (Figure 3B). Although the ESI for

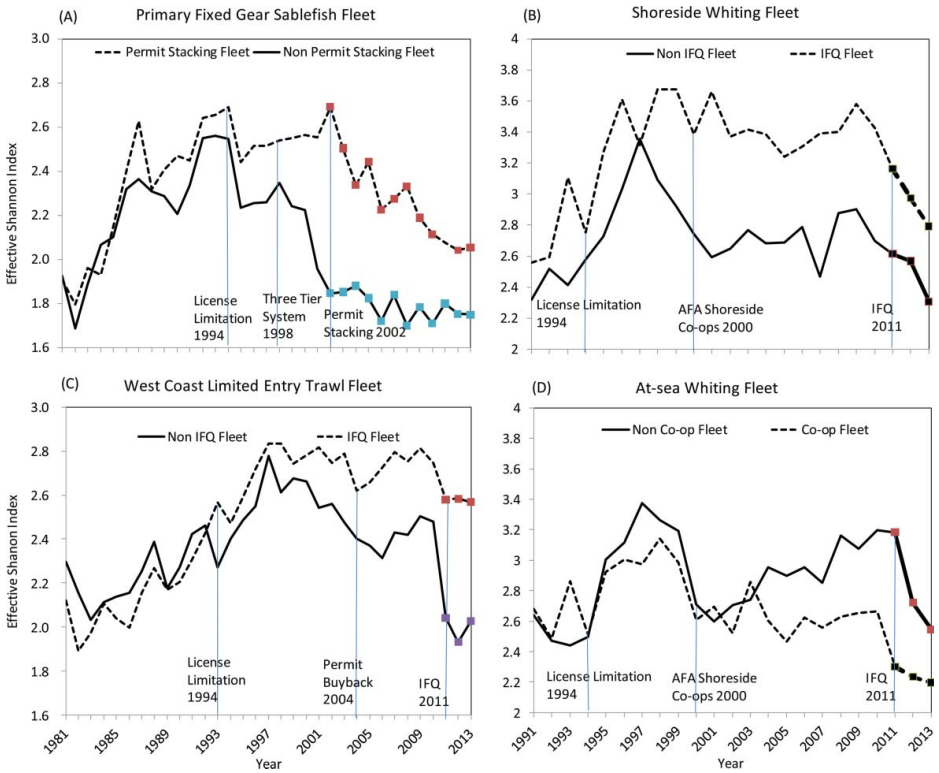

Figure 3. Trends in average diversification measured by the effective Shannon index for groups of vessels participating in West Coast catch share programs prior to their implementation (A) West Coast limited access fixed gear sablefish fleet, (B) the shoreside Pacific whiting fleet, (C) the West Coast limited entry trawl fleet, and (D) the at-sea Pacific whiting fleet.

this fleet in 2013 is at the lowest level since 1991, there is no significant difference between the average from 2000 to 2010 and that in the period after 2010. For the shoreside whiting vessels that continued to fish for Pacific whiting after the IFQ was implemented, there is a significant drop in average ESI ($p = 0.04$) after 2010 as compared to the 2000–2010 period. Both for vessels that continued fishing Pacific whiting and those that did not, a declining trend in ESI had already begun after 2009, perhaps in anticipation of the IFQ. As with the other fleet groups discussed previously, diversification for the vessels that did not participate in the IFQ was lower than that of the IFQ fleet both before and after the IFQ.

In contrast to the shoreside component of the fishery, the at-sea whiting vessels that did not participate in cooperatives after 2011 were actually more diversified than those that did participate in cooperatives (Figure 3D). The average diversification level for this fleet had been increasing between 2001 and 2010 as a consequence of declining dominance of pollock revenues for this fleet. This trend reversed after 2011 although there is no significant difference in the average level of diversification between 2000–2010 and 2011–2013. For the fleet that remained active in the Pacific whiting cooperatives, there was a significant drop in diversification ($p < 0.01$) after 2010.

Although diversification levels mostly decreased following implementation of catch shares, average vessel revenues (adjusted to 2005 dollars) generally rose both for vessels that remained in and those that left the catch share fisheries (Table 2), with the exception of vessels that exited the fixed gear sablefish fishery. A two-tailed *t*-test suggests that these increases in average revenues are only statistically significant for the IFQ and non-IFQ limited entry trawl fleets and the shoreside whiting IFQ fleet. However, it is notable that average revenues increased for a substantial majority of vessels in all these fisheries. This is true both for vessels that stayed in the catch share fisheries and those that exited. One exception is for vessels that left the fixed gear sablefish fishery, where 71% saw a decrease in average revenues in the years following the catch share implementation.

There is no evidence to suggest that declines in diversification led to increases in variation in revenue (Table 2). The average CV of revenues did not change significantly except for the shoreside whiting fleets and the at-sea whiting fleet that remained active in the cooperative; however, in those cases, the average CV of revenue declined. For all the catch share fisheries and fleets (other than the vessels that did not remain in the limited entry trawl IFQ), less than 50% of the individual vessels had an increase in CV of revenues post catch share implementation.

Discussion

Diversification can reduce variation in annual revenue for individual fishing vessels and can increase the minimum annual revenue relative to average revenue, reducing the risk of a business failure (Kasperski and Holland 2013). However, the diversification levels generally declined for West Coast vessels over the last few decades. This decline coincided with implementation of limited access programs in most West Coast fisheries over that period. These programs generally provided permits at nominal cost to current participants but increased costs for new entrants who had to purchase one of a strictly limited set of permits from an existing permit holder. Our results show that vessels that entered West Coast fisheries later are, on average, less diversified than those that entered earlier; however, diversification declined even for the fleet of vessels active since 1981.

Table 2. Mean revenue and CV of revenue before and after implementation of catch share systems.

Fishery	Fleet	Percent change in mean revenue (%)	*t*-test *p*-value on change in mean revenue	Percent of vessels with increased revenue (%)	CV of revenue pre-catch Share	CV of revenue post-catch share	*t*-test *p*-value on change in CV of revenue	Percent of vessels with increased CV of revenue (%)
Primary fixed gear sablefish fleet	Non permit stacking	−4	0.89	29	0.47	0.48	0.69	44
	Permit stacking	18	0.34	58	0.37	0.41	0.25	46
West Coast limited entry trawl fleet	Non-IFQ	33	0.04	74	0.33	0.33	0.92	58
	IFQ	54	0.00	86	0.20	0.22	0.37	46
Shoreside whiting fleet	Non-IFQ	16	0.59	71	0.25	0.16	0.06	43
	IFQ	72	0.00	100	0.26	0.16	0.04	36
At-sea whiting fleet	Non co-op	32	0.43	80	0.36	0.32	0.74	30
	Co-op	21	0.79	95	0.37	0.14	0.00	10

Diversification declined further following implementation of catch share programs on the West Coast. For the limited entry fixed gear sablefish and limited entry groundfish trawl fisheries, diversification declined both for vessels that stayed in after implementation of the programs and for those that exited.[6] For the Pacific whiting fishery, diversification declined for vessels that stayed active in the IFQ or cooperatives. Changes in diversification pre- and post-catch share were not significant for vessels that dropped out of the Pacific whiting fishery post-catch share; however, an increasing trend in diversification was reversed for the at-sea whiting fleet that did not fish under cooperatives.

Although our results show declines in diversification following implementation of catch share programs in most cases, all but the sablefish permit stacking program are quite new; therefore, it is uncertain how diversification will be affected in the long run. Notably, the groundfish trawl IFQ did not allow transfers of quota share until 2015, just within-year sales of quota pounds, which may have inhibited consolidation and specialization. With additional consolidation, we might expect to see further reductions in diversification. However, IFQ programs that allow divisibility and transferability of catch privileges do offer the opportunity for vessels to re-enter these fisheries by purchasing or leasing quota. There have in fact been some new vessels participating in the groundfish trawl sector under the IFQ program although most of these are fixed gear vessels that had been participating in the sablefish fishery.

Factors other than catch share programs may also have influenced diversification. For example, coincident with the rationalization of the Pacific whiting program in 2011, the Eastern Bering Sea pollock quota increased by 50% from approximately 0.8 to 1.2 million metric tons, resulting in many vessels expending additional effort in the more lucrative pollock fishery in Alaska and less in the Pacific whiting fishery, which might partially account for the decline in diversification among the at-sea Pacific whiting fleet. Thus, while trends are indicative of changes that occurred as a result of the implementation of catch shares, they do not necessarily imply causation, and additional work is necessary to isolate the impact of catch share programs on diversification.

Reduced diversification may increase financial risk, all else equal, but it should be noted that in most cases, the limited access and catch share programs that restricted access were motivated in large part by the desire to remove excess capacity and promote economic efficiency within the programs. Catch share programs may also create more security and stability in vessels' landings, which may offset effects of less diversification. We found that year-to-year variation in revenue decreased post-catch share for the majority of vessels, including those that exited the catch share fisheries. We also found that in most of the catch share fisheries, a majority of vessels received increases in average revenues in the years following the catch share implementation.

Overall, our results suggest that there may be a tradeoff between the efficiency gains enabled by restricting access and the risk-reduction benefits associated with greater diversification. However, initial indications suggest that while catch shares may further contribute to reducing diversification, this does not necessarily mean that catch shares lead to an increase in financial risk. Since most of the catch share programs evaluated are quite new, it is too early to draw firm conclusions about their impacts, and continued research on more catch share fisheries operating over longer durations would be useful to clarify whether and how catch share programs impact diversification and financial risk.

Notes

1. Because an individual or firm might own more than one vessel and be diversified although each vessel is not, it would be preferable to have the owning entity rather than the vessel as the unit of analysis. However, comprehensive ownership information is not available making it impossible to take this approach with our large sample.
2. Kasperski and Holland (2013) use the Herfindahl-Hirschman Index to measure diversification. The effective Shannon index yields very similar results in terms of trends, but the effective Shannon index is somewhat more intuitive as it rises with increased diversification and has an intuitive meaning when revenues are evenly spread across fisheries. A variation on the Herfindahl-Hirschman index using one over the sum of squared proportions would also be a good alternative for measuring diversification as it increases with diversification like ESI and exhibits similar but slightly different properties.
3. The 2 years need not be consecutive.
4. These are not balanced panels—not all vessels included in calculating ESI in a given year appear in all years.
5. The average value of the ESI index can vary substantially year to year, even when averaged across large numbers of vessels, due to large fluctuations in landings and value of major fisheries, which then alter the concentration of earnings for large numbers of individuals. For example, on the West Coast, total landed value in the Dungeness crab fishery fluctuates dramatically year to year, which can affect the diversification scores for large numbers of vessels. Kasperski and Holland (2013) found a large increase in concentration (drop in diversification) for West Coast and Alaska vessels in the year of the Exxon Valdez oil spill.
6. As a reviewer noted, fishers in the derby fishery for sablefish with seasons falling to as short as 10 days might have been essentially forced to be diversified to cover fixed costs for participating in a 10-day derby.

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